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Measuring Mountain Pine Beetle Trends and Impact in Lodgepole Pine

by

Douglas L. Parker, Entomologist

INTRODUCTION

The development of sampling techniques to evaluate mountain pine beetle, Dendroctonus ponderosae Hopkins, infestation trends and damage is one of the major problems confronting entomologists in the Intermountain Region. Until these and other factors can be accurately estimated, there can be no sound basis on which to determine the need for or against control of this insect.

The main obstacle to obtaining meaningful trend and impact data is the complex environment of this beetle. No matter how many individual factors can be measured, this biological complex cannot be expressed mathematically in its entirety. For this and economic reasons, efforts have been directed toward intensive sampling of trend and impact in localized areas. The data are cursory and variable, but they are the best available at present for advising land managers. The following is a discussion of the sampling techniques used to measure mountain pine beetle population trends and impact, the partial results of one study, and a discussion of the results.

METHODS

For the past five years, biological data have been collected on the activity of the mountain pine beetle in lodgepole pine stands in the southwestern corner of Yellowstone National Park.[1/] The reason for sampling this area was based on the decision of the National Park Service not to suppress the beetle infestation. This decision provided the opportunity to study the attack behavior of this beetle in an undisturbed environment. Eighty-five permanent plots were established in a grid pattern at ten-chain intervals on five lines (17 plots per line) within a one-mile square area. Green stand data were collected during the first year of the survey on every other plot on three of the five lines, 27 plots in all. Tree mortality was recorded on all 85 plots each year. Trees were categorized in 2-inch diameter classes beginning at 5-inch d.b.h. (diameter at breast height). The variable plot method of cruising was used with a basal area factor (BAF) of 10 used on green stand plots and a 5 BAF on mortality plots.

A statistical analysis of between plot variation for green stand and mortality data will not be provided in this report. This information will be reported after this study is completed.

1/ A similar study is now underway in an uncontrolled infestation on the Bridger National Forest, Wyoming. The final results of both of these studies will be reported later.

RESULTS AND DISCUSSION

In 1965, before the infestation reached the Park, there were 212.3 live lodgepole pine trees per acre. Subsequent attrition of the stand by the mountain pine beetle caused the green stand to decrease as follows: 208.6 in 1966, 203.3 in 1967, 189.4 in 1968, 161.9 in 1969, and 158.9 in 1970. The depletion may seem high, but 74.8 percent of the stand above 5 inches d.b.h. was still green. If trees below 5 inches d.b.h. were included, the percentage of green trees would be higher. A breakdown of the green stand structure by diameter class above 5 inches d.b.h. follows:

Year	GREEN STEMS/ACRE — Diameter Classes							
	6	8	10	12	14	16	>16	Total
1965 (Original Green Stand)	79.7	63.0	39.8	17.4	8.2	2.0	2.2	212.3
1966	79.4	62.1	39.0	16.8	7.7	1.7	1.9	208.6
1967	79.4	61.2	37.9	15.4	6.4	1.4	1.6	203.3
1968	79.4	58.3	34.0	12.2	3.9	0.8	0.8	189.4
1969	77.6	50.3	23.3	7.7	1.8	0.5	0.7	161.9
1970	77.6	49.8	22.2	7.1	1.4	0.3	0.5	158.9

The relative number of living trees above 12 inches d.b.h. is used, along with other factors, in predicting future beetle population trends. Recent studies[1/] have shown that large diameter trees generally have thicker phloem and these trees generally produce a surplus number of beetles. Therefore, an abundance or lack of large diameter trees has a direct influence on population trends.

During the first five years of the infestation, 53.4 trees per acre were lost. Mountain pine beetle-caused mortality increased steadily from 1966 to 1969, but decreased significantly in 1970. The peak of the infestation was in 1969 when 27.5 trees per acre were killed. A resumé of mortality follows:

1/ Amman, G. D. 1969. Mountain pine beetle emergence in relation to depth of lodgepole pine bark. USDA, Forest Service, Intermountain Forest and Range Exp. Sta. Res. Note INT-96, 8pp., illus.

Year	DEAD STEMS/ACRE — Diameter Classes							
	6	8	10	12	14	16	>16	TOTAL
1966	0.3	0.9	0.8	0.6	0.5	0.3	0.3	3.7
1967	--	0.9	1.1	1.4	1.3	0.3	0.3	5.3
1968	--	2.9	3.9	3.2	2.5	0.6	0.8	13.9
1969	1.8	8.0	10.7	4.5	2.1	0.3	0.1	27.5
1970	--	0.5	1.1	0.6	0.4	0.2	0.2	3.0
TOTAL	2.1	13.2	17.6	10.3	6.8	1.7	1.7	53.4

There was an adequate number of large diameter infested trees each year during the infestation to produce a surplus of beetles until 1970 when a decrease occurred. The lack of a sufficient number of susceptible trees appears to have been the limiting factor. Possibly, emerging beetles flew to neighboring stands with more favorable host conditions. However, there is no information to support this hypothesis. In 1971, emergence data from marked trees in the cruise area will be collected to determine if there is a relationship between emergence and attack levels recorded each year during the infestation.

An analysis of tree mortality by 2-inch diameter classes showed that a greater percentage of large diameter trees had been lost. However, trees above 12 inches in diameter comprised a relatively small proportion of the original green stand (14 percent) of the trees above 5-inches d.b.h. Trees 5.0 to 11.9 inches d.b.h. comprised a larger percentage of the green stand; and, even though a greater number of trees in these diameter ranges were killed, the percentage of mortality was less. Again, mortality of trees below 5.0 inches in diameter was not measured, but it should be emphasized that the mountain pine beetle rarely attacks trees in the smaller diameter classes. A summary of the percent cumulative mortality by 2-inch diameter classes follows:

Year	PERCENT CUMULATIVE MORTALITY — Diameter Classes							
	6	8	10	12	14	16	>16	TOTAL
1966	0.4	1.4	2.0	3.6	6.1	15.0	13.6	1.7
1967	0.4	2.9	4.8	11.5	22.0	30.0	27.3	4.2
1968	0.4	7.5	14.6	29.9	52.4	60.0	63.3	10.8
1969	2.6	20.2	41.5	55.7	78.0	75.0	68.2	23.7
1970	2.6	21.0	44.2	59.2	82.9	85.0	75.0	25.2

Although logging is prohibited in the Park, sawtimber stands have been depleted below a merchantable state. Generally, stands with less than 25-30 square feet of basal area per acre of trees 10 inches and above are not considered economically operable. A summary of the remaining basal area per acre by year follows:

Year	BASAL AREA (sq. ft.)/ACRE OF GREEN STAND Diameter Classes					
	10	12	14	16	>16	TOTAL
1965	21.6	13.5	8.2	3.0	4.2	50.5
1966	21.2	13.0	7.7	2.5	3.6	48.0
1967	20.6	11.9	6.5	2.0	2.9	43.9
1968	18.5	9.5	4.1	1.1	1.4	34.6
1969	12.7	6.3	2.0	0.6	1.2	22.8
1970	12.1	5.8	1.6	0.3	0.9	20.7
Percent Remaining	56.0	43.0	19.5	10.0	21.4	41.0

SUMMARY

Data collected during stand cruises have added greatly to the understanding of mountain pine beetle infestation trends, annual attrition, buildup ratios, etc. However, the most important benefit has been in providing meaningful information to land managers. As an example, data collected in Yellowstone National Park were used as a basis for developing an economic evaluation of the mountain pine beetle control project on the nearby Targhee National Forest. The analysis revealed that the cost-benefit ratio for continuation of suppression was unfavorable and the project was discontinued.

Studies on trend and impact in Yellowstone National Park will be continued until the infestation has concluded. A study to determine the relationship between numbers of emerging beetles and annual tree attrition will be conducted this summer. Also, information on the relationship between attack density and final emergence by tree diameter and height will be obtained.